A REVIEW OF THE MARSUPIAL GENUS *SMINTHOPSIS* (PHASCOGALINAE) AND DIAGNOSES OF NEW FORMS.

By Ellis Troughton.

(Seven Text-figures.)

[Read 30th September, 1964.]

Introduction.

In his arrangement of the Genus *Sminthopsis* in the British Museum *Catalogue of the Marsupialia* (1888) Oldfield Thomas was limited to such sparse and inadequately localized material that this mouse-like group of terrestrial marsupials, with the description of additional species, has become involved in hopeless confusion. Referring to the unusually negative diagnostic features of the genus, Thomas, in a footnote to his "Synopsis of Species", stated that "Owing to the close resemblance existing between the skulls and teeth of the different species of *Sminthopsis* it has been found impossible to make this synopsis very definite in its details, but it is nevertheless thought useful to draw attention to such characters as, by reference to the fuller descriptions, will assist in the identification of specimens".

Lack of specific series also rendered his diagnoses of the physical characteristics far too general on such specific criteria as the sole-pad pattern, and the presence or absence of smooth or minutely striated apical areas. The comparative length and degree of incrassation of the tail also proves to be variable in individuals of several species, according to seasonal and environmental conditions. Such variation, combined with the general lack of distinctive coloration, has created the impression that specific differentiation is often impossible. As a result, specific relationships have been hopelessly confused, and a preposterous distribution attributed to several of the species.

The diagnostic pattern of the pads at the base of the toes may briefly be defined as: (*a*) In *crassicaudata* fine overall granulations, the subspecies *centralis* with an enlarged row of granules down the centre of each pad; (*b*) In *murina/leucopus* a longitudinal apical row of enlarged granules which, with wearing down, may appear as faintly serrated apical pads; (*c*) In *lumholtzi* the well-defined oblong-ovate apical areas have microscopic transverse striae, not conceivably due to granular wearing down; (*d*) In *larapinta* there is a small smoothly rounded apical area set amongst the relatively minute granules, as distinct from the enlarged apical "bead" on the pads of *macrura*. Two notable exceptions, *Sm. hirtipes* and *longicaudatus*, have the soles as subsequently described and figured.

Confusion regarding these sole-pad patterns has resulted mainly from a general neglect of the elementary collecting method never to skin the first specimen of any small mammal from each location, and then alternatively to skin and preserve specimens of a series in spirits. Not only are the sole-pads distorted by drying, but pinning-down *through* the apical pads obliterates their pattern. The feet should invariably be held down by pins crossed at the middle, preferably with the soles upward to avoid flattening the pads. The specific importance of the sole pattern in a genus so lacking in distinctive coloration and cranial characters is indicated by the following summary.

In his description of *murina* in the *Catalogue*, Thomas recognized a variation in the sole-pads (due to wear in this species) when stating that the finely granulated projections at the base of the toes were without "distinct transversely striated pads, although on their summits *several of the granulations sometimes coalesce and form small irregular and smooth pads*". This observation anticipated the eventual subspecific merging by Tate (1947) of *leucopus* of Tasmania and *ferruginifrons* (N.S.W.) with

murina. But evidently neither Thomas nor Tate appreciated that in *murina* wearing down of the apical rows of enlarged granules tends to produce smooth oblong apical areas, with the grooves between the worn granules *appearing as transverse striations*.

Evidently, failure to apply this coalescence of granules specifically resulted in Thomas according his "*leucopus*" a phenomenal range from Cape York to Tasmania, while restricting *murina* to "Australia south of the tropics". In doing so, Thomas misapplied the description and figure of the sole-pads of a "Cape York" specimen of *lumholtzi* to his description of *leucopus*. Because the feet of Gray's type of *leucopus* (Tasmania) were dried and distorted, Thomas, in his *Catalogue*, was evidently dependent on the two spirit specimens of the six listed for *leucopus* when describing and figuring the feet as having striated apical and hallucal pads.

However, examination of Pl. xxiii in the *Catalogue* makes it obvious that no wearing down of the apical granules depicted for *murina* (Fig. 7) could conceivably produce the clearly defined and minutely striated apical areas shown for *leucopus* (Fig. 6). From the relatively much larger foot and sole-pattern depicted for his "*leucopus*", compared with that of *murina*, it seems obvious that Thomas chose the Cape York specimen to illustrate the pes of his *leucopus* (*sensu lato*). This specimen cannot now be traced in the British Museum, or the Queensland Museum from which it was borrowed, but beyond doubt the pes figured for *leucopus* in the *Catalogue* agrees completely with the pes of the much larger-skulled *Sm. lumholtzi* Iredale & Troughton (1934), a replacement name for the species described as *Phascologale virginiae* by Collett (1886 and 1887), and not of De Tarragon (1847).

The holotype of *lumholtzi* is the specimen in the Oslo Museum, collected by Carl Lumholtz at Herbert Vale on the southern slopes of the Atherton Tableland, N.E. Queensland. While confirming Collett's description of the distinctive cranial characters of this specimen, in the *Catalogue* under "*Sminthopsis virginiae*", Thomas added that its sole-pads so far as discernible in the dried specimen were "precisely like those of *Sm. leucopus*". Therefore, the sole-pattern figured for *leucopus* (Pl. xxiii, 6) and presumably drawn from the "Cape York" spirit specimen is characteristic of *lumholtzi*, and not of *leucopus* = *murina* as previously assumed.

Because this assumption is responsible for much subsequent confusion regarding the presence or absence of striated apical pads, the question has been reviewed in detail before proceeding with a review of the genus. It is not necessary to discuss the "grouping" of species, essayed by Tate in his "Revision of the Dasyuridae" (1947), because preoccupation with fitting species of extremely generalized characters into groups, on limited material and without due knowledge of zoo-geographical conditions, has prejudiced the diagnostic value of Tate's important review of the genus *Sminthopsis*.

The *crassicaudata–macrura* Complex.

Originally described as *Phascogale crassicaudata* by Gould (1844) from the Williams River south of Perth (W.A.), this small species is readily identified by the uniformly fine granulation of the sole-pads, the large "leafy" ear with contrasting blackish marks on the outer anterior and inner margins of the lobe, and especially by relatively the shortest and most consistently incrassated tail of any species. Gould described and figured the tail (*Mamm. Austr.*, Pl. 47) as "much swollen, *especially in the middle*" which imparts the "spindle-shaped" character of the tail of *crassicaudata*, and which is in absolute contrast with the tail of *macrura* figured by Gould (Pl. 46).

The striking contrast in both form and colour makes it difficult to comprehend why Thomas, without explanation, placed *macrura* as a synonym of *crassicaudata* in the *Catalogue*; he also synonymized *froggatti* Ramsay (1887) the year after its description, from the coast near Derby, about 1,100 miles north of the type locality of *crassicaudata*. But Tate (1947) confirmed the specific status of *macrura* after examining the two "topotypes" from S.E. Queensland in the British Museum. Unfortunately, Tate made the cranial comparison with *murina* and, uncertain of the specific affinity of *crassicaudata centralis*, actually included *froggatti* of the north-west coast as a race of the eastern *macrura*.

Lack of adequate localized material and general knowledge of the zoo-geographical complex of soils and vegetation evidently confused the specific problems for both Thomas and Tate. For example, in the *Catalogue* Thomas listed only nine specimens of *crassicaudata* while recording the habitat as the "Whole of Australia (not yet recorded from the extreme north)". Included were Gould's type from south of Perth (W.A.), and the "co-types" of his *macrura* from the Darling Downs, S.E. Queensland. One specimen from the Darling River (N.S.W.) collected by the explorer Charles Sturt, and another from "South Australia" presented by Sir George Grey, when Governor of the State, are in the British Museum. The remaining three specimens are listed as "Purchased", from West Australia, Melbourne, and Queensland.

The subspecific distinction of *crassicaudata centralis* Thomas (1902) was confirmed by Finlayson (1933) in reviewing the Dasyuridae of the Lake Eyre Basin (S.A.). He also recorded an extraordinary increase of *centralis* accompanying the migratory waves of *Mus musculus* from north to south in 1930–1932. Coincidentally, an increase of the southern form was observed in settled areas along the Murray River east to Mildura. Specimens of the short-tailed "typical" *crassicaudata* are in the Australian Museum south-east to Albury (N.S.W.). But northward to the Queensland border, east of the coastal ranges, extensive series of Museum specimens display a bewildering variation with increasing size, while retaining the characteristic tail-formation and fine granulation of the sole-pads.

However, quite typical specimens of *centralis* in the Australian Museum extend its range some 150 miles across the South Australian border, to Thylungra in south-western Queensland. Because neither these specimens of *centralis*, nor the series assigned to *crassicaudata* from northern New South Wales, are reconcilable with Gould's description and colour-plate of *macrura*, it is accorded specific status, pending examination of the syntypes in the British Museum. This view is supported by specimens in the collections of the Australian and Queensland museums, as recorded in the descriptive notes on *macrura*.

Sminthopsis crassicaudata centralis Thomas.

Sminthopsis crassicaudata centralis Thomas, 1902, *Ann. Mag. Nat. Hist.*, (7), 10, p. 492. Type from Killalpaninna, east of Lake Eyre, S.A.

Diagnosis. According with the detailed comparative description by Finlayson (1933); a longer-tailed and more brightly-coloured race, the colour ranging from the "pale isabella" of the type, through buffy grey, to "rich vinaceous cinnamon". The variable incrassation of the tail at its maximum development may be greater than in the typical race (Finlayson, 1933). Sole-pads more coarsely granulate, with the outer inter-digital pads less inflated, and the three pads with a single row of enlarged granules down the midline, compared with the overall fine granulation in the typical form. Cranial and dental differences slight, the canine averaging longer but variable in lateral contour; pm^1 larger, and pm^3 and pm^4 almost subequal, the disproportion therefore less than the typical *crassicaudata*. Mammae 8 or 10.

Specimens examined. An adult ♀ from no. 1 bore 64 miles south of Innamincka (S.A.) is reasonably topotypical, also four from around Innamincka, near the Queensland border, collected in 1961 by Basil J. Marlow and R. D. Mackay; a pair from Thylungra (Q'ld) 260 miles east of Birdsville, presented by Dr. G. Gregory; and a pair from Barcarolle Station on the Thompson River, 130 miles south-west of Longreach, presented by the late F. L. Berney; in the Australian Museum.

Remarks. The bright dorsal coloration ranges from a topotypical pale isabella through cinnamon-buff to clay colour (Ridgway). Measurements in adults of both sexes are: ear-length 19–21·8; tail 66–71, somewhat longer than Finlayson's 64–66; pes 15–17 mm. The variable profile of the upper canine may assume the shorter "premolariform" shape, with a distinct posterior talon, as described by Tate (1947, p. 124) for a ♀ from the Birdsville area, over the Queensland border about 200 miles north of Killalpaninna. This A.M.N.H. specimen (fide Tate) "agrees in all essential features with the type of *stalkeri*", listed as a race of *larapinta* by Tate. As the comparative features of a strongly

incrassated and pedunculate tail (65–68 mm.), wholly granular pads, and large ears are equally comparable with *centralis*, further examination of the type of *stalkeri* may prove it synonymous with this northern race of *crassicaudata*. Despite Tate's understatement of the distance between the type locality of *stalkeri* on Alroy Downs, 250 miles from the Gulf of Carpentaria, in allying the Birdsville specimen, a comparison with *centralis* would seem more convincing because of the occurrence of that subspecies from intermediate localities. Also because Thomas made no reference to his *centralis* in describing *stalkeri*, while Tate wrongly regarded *centralis* as a race of *macrura* of south-eastern Queensland.

The suggestion by Tate (*loc. cit.*, p. 122) that *murina constricta* may equal *centralis*, as a race of *macrura*, is not sustained by the few objective details of Spencer's description, which also do not support the association of *constricta* as a "variety" of *murina*.

Sminthopsis macrura Gould.

Podabrus macrurus Gould, *Proc. Zool. Soc. London*, 1845, p. 79; *id.*, *Mamm. Austr.*, 1849, Pl. 46 (animals). Locality, Darling Downs, S.E. Queensland.

Syntypes. Two in the British Museum, Nos. 46.4.4.62 & 87.5.4.1; a third in the Liverpool Museum destroyed by enemy action.

Diagnosis. According to Gould's description and colour-plate, as in contrast with his description and figure of the typical *crassicaudata* (Pl. 47). The decidedly longer tail, incrassated for about the basal 3rd, tapering to a slender tip, and darker and more coarsely haired; tail length of adults examined 77–82 mm., compared with 80·5 (about $3^2/_{12}$ in.) given by Gould from a "co-type". Ear relatively short, 16·5–17 mm., with less contrasted markings. Sole-pads with coarser granulations, and small rounded apical "beads" equalling 2 or 3 granules.

The cranial and dental measurements of an unsexed co-type skull of *macrura* from the Darling Downs, listed in the *Catalogue*, against those of a presumably typical specimen of *crassicaudata*, indicate some slight disparity in proportions. However, the upper canines are relatively longer and broader based, and the premolars are characterized by the very small pm^1 being about half the size of pm^3, which is less than half the size of pm^4. The relative smallness of the 1st and 3rd premolars distinguishes *macrura* from both northern and southern (N.S.W.) forms of *crassicaudata*, and from *centralis*, which have relatively subequal premolars.

Specimens examined. In the Australian Museum, a young adult ♀ (M.7402) from the Warialda district, 30 miles east of Moree (N.S.W.), and two sub-adults (♀) from Mungindi on the Queensland border; lent from the Queensland Museum, an adult ♂ (J.5746) from Oberina near Roma, an adult ♂ from Texas, on the border east of Goondiwindi, and three more or less adult specimens, from Milmerran on the Darling Downs, Dalby, and the Rannes district, 100 miles north of Mundubbera, south-east Queensland.

Remarks. The specific status of *macrura* is confirmed by specimens in the Australian Museum from Mungindi on the Queensland border (ear-length 15–16 mm.), and by several specimens of the large-eared northern form of *crassicaudata* (ear 20–23 mm.) from the same district. A young adult ♀ of *macrura* (M.7402) from the Warialda district, 100 miles south-east of Mungindi, with an ear-length 16·5 and tail 81·5 mm., also supports specific distinction in comparison with an unusually long-tailed breeding ♀ of *crassicaudata* from Mungindi (ear 20 and tail 67 mm.). A sub-adult ♂ from Cunnamulla (Q'ld), 200 miles north-west of Mungindi, provides the western-most record of the northern form of *crassicaudata*, thus confirming the distinction of *macrura* and circumscribing its range.

A Queensland Museum adult ♂ (J.5746) from the Roma district (Q'ld) has a remarkable thickening of the tail-base (7·3 mm.), as described by Gould (3½ lines—7·5 mm.) for a "co-type" of *macrura* from the adjacent Darling Downs. This seasonal fattening, as with the pigmy phalanger (*Dromicia*), markedly changes the appearance of the tail by expansion of the skin and hair, but the outer half tapers to a slender point, as described and figured by Gould. While this variable feature is reduced in drying of

the skin, some indication may have influenced Thomas to identify *macrura* with *crassicaudata* in the *Catalogue*.

However, Tate's examination of the syntypes of *macrura* (1947, p. 122) supported its specific distinction. Unfortunately, his cranial comparison with *murina* provided no diagnostic criteria, and certainly no evidence warranting the inclusion of *centralis* and *froggatti* as subspecies of *macrura*; and least of all Spencer's *constricta* from Oodnadatta, 100 miles west of Lake Eyre, with a relatively very broad foot. The adult male in the A.M.N.H. listed by Tate as from Malbon "west of Townsville, Central Queensland", is actually from within 150 miles of the Northern Territory border, 450 miles west of Townsville. In view of the occurrence of *larapinta* at the intermediate locality of Richmond, it seems more credible that the Malbon specimen (tail 80 mm.) represents that species.

From a comprehensive analysis of considerable material, and Gould's descriptions and figures, the relationship of *macrura* appears to rest with *larapinta* rather than *crassicaudata*. However, the specific status of *macrura* is maintained and discussion of specific alliance is deferred pending study of the syntypes in the British Museum, and selection of a lectotype.

Sminthopsis monticola, sp. nov. (Fig. 1A–B.)

Holotype. Young adult ♀ A.M. No. B.9579, from Lawson, town altitude 2,403 ft, on the Dividing Range, 56 road miles west of Sydney; presented by E. H. Palmer, November, 1885.

Diagnosis. Body and tail proportions similar to those of the Roma (Q'ld) specimen of *macrura* (J.5746), but basal width of tail 10 mm., compared with 7·3 and the 7·5 of Gould's co-type; the length of tail (77 mm.) and the basal incrassation in absolute contrast with the tail-formation of typical *crassicaudata*. Ear length 19·5 (fig. 1A) intermediate between *macrura* (16·5) and a range of about 20–23 mm. for *crassicaudata*; tragus larger and more broadly expanded above than in *crassicaudata*, with the rear margin arising from the mid-base rather than the edge of the tragus. The relatively broad pes (fig. 1B) distinguished from *crassicaudata* by its larger granulations, and smooth bead-like apical summits to the pads, equalling about three granules as in *macrura*. Cranial proportions as in northern *crassicaudata*, and *macrura*, but relatively broader at m^3; nasalia relatively narrower and straight-edged. Canine rather short and broad, with a minute anterior and decided posterior cingular talon; pm^3 definitely larger than in *macrura*, the premolars appearing more evenly subequal than in *crassicaudata*, because the more conical pm^4 lacks a decided cingular ridge and the strong posterior talon present in the other species.

Dimensions of holotype. In spirit: head and body 78; tail 77; pes 16·8; ear 19·5 mm. Skull: Greatest length 25·4; zygomatic breadth 14·2; interorbital width 4·7; nasals 8·9 × 2·2; palate, length 13, ant. foramina 2·4 × 1·4; breadth at m^3 8·5; upper tooth-row 12·7; canine height 1·7; p^4 base 1·3; m^{1-3} 5·2 mm.

Remarks. The holotype, in general form and according to the diagnosis, is distinguished so positively from *crassicaudata* that specific comparison rests with *macrura*, from which it differs in several diagnostic features, further confirming the specific status of *macrura*. From the wet holotype, a dark rostral mark is present, and the dorsal coloration seems of a brighter cinnamon-rufous compared with wet and dry specimens of *macrura*, and Gould's figure, but the tone may have been affected by long spirit preservation. The excessive thickening of the proximal half of the tail parallels the maximum seen in pigmy phalangers from the Blue Mountains, which may be indicative of the richer food resources of the habitat.

Sminthopsis granulipes Troughton.

Sminthopsis granulipes Troughton, 1932, *Rec. Austr. Mus.*, vol. 18, no. 6, p. 350, fig. 1, ear & pes.

Holotype. Adult ♀ No. 669, in Palmer's register of the "old collection" in the Australian Museum; locality King George's Sound, south Western Australia, entered as "Coll. George Masters 1869?".

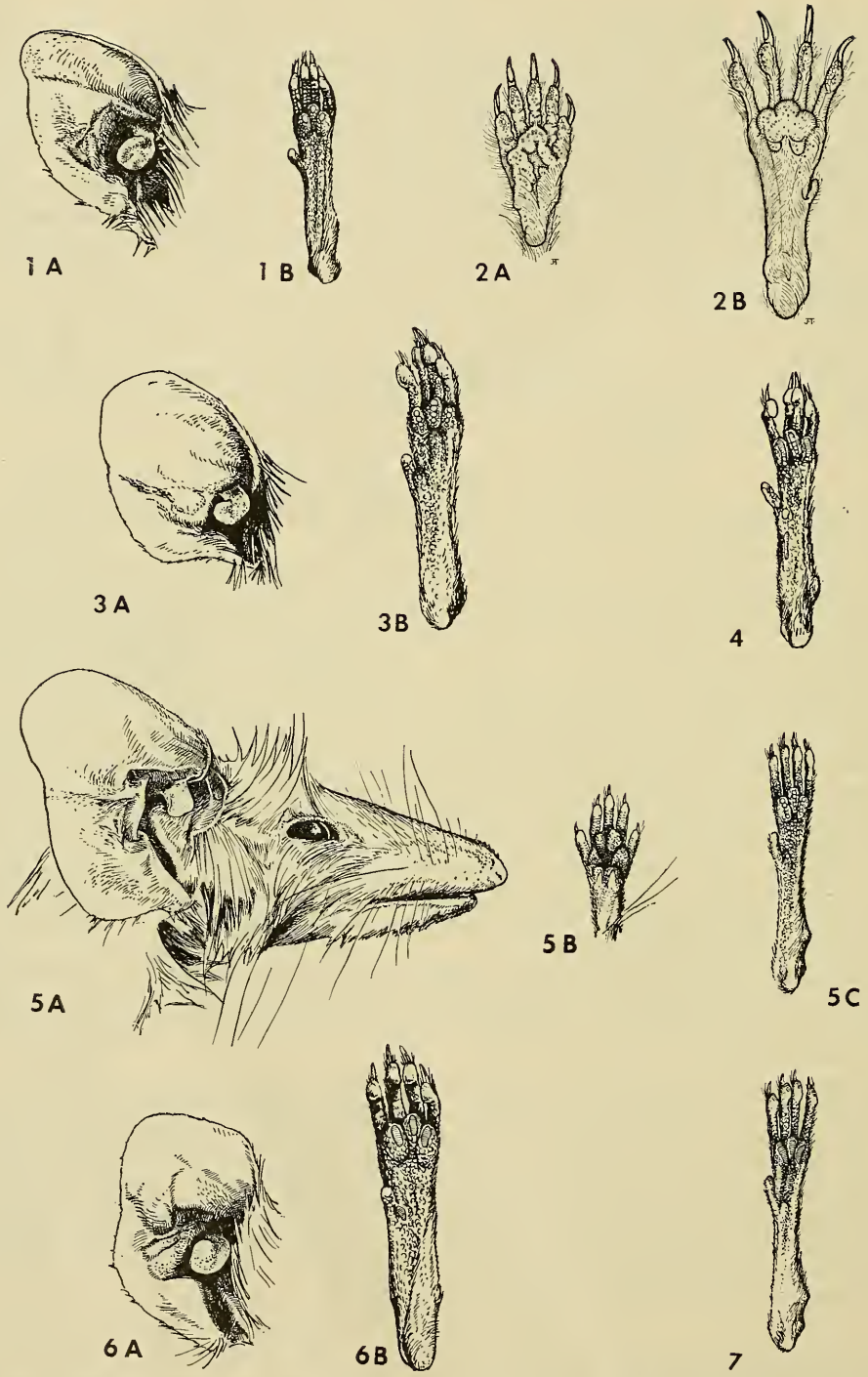

Fig. 1, A-B. *Sminthopsis monticola*, sp. nov. Holotype. 1A showing shape of ear and unusually broad tragus. Fig. 1B, the pes with smooth summits to the pads, equalling several of the large granules. Aust. Mus. No. B.9579. B. Bertram del.

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Diagnosis. Body and tail of similar proportions to *crassicaudata*; but distinguished by the decidedly shorter and broader ear, not surpassing the centre of eye when pressed forward, and greater breadth due to marked convexity of the lower outer 3rd of the conch. Pads of manus and pes more finely and evenly granulated than in *crassicaudata*; the raised palmar area with a series of convolutions not divided into definite pads; pes with smaller central pad not separated from the two outer by definite grooves, the summits without coarsened granules as in *crassicaudata.* Tail incrassated. Mammae in holotype 5 and 6 a side, with traces of another teat, doubtless equalling 12. Skull proportionately larger and stouter than in *crassicaudata*; dentition as originally described.

Dimensions of the holotype. In spirits: head and body 87; tail 55; pes 13·5; ear from outer base 17·5; greatest width 15·5 mm. Skull: Greatest length 27·3; zygomatic breadth 15·2; nasals 10 × 2·3; interorbital 5·5; palate, length 15·6, ant. for. 3·4; breadth at m^3 9; upper tooth-row 14·1; molars$^{1-3}$ 4·9 mm.

Remarks. Re-examination of the holotype, in comparison with a series of *crassicaudata* from Tambellup, presented by F. R. Bradshaw in 1929, confirms the original description. The absence of a definite outer ulnar pad with a smooth elongated summit, characterizing *crassicaudata*, is a notable feature. In a brief personal note in May, 1939, L. Glauert of the Western Australian Museum wrote: "By the way we have today received our third *S. granulipes* Troughton—the localities are (1) female *with 12 young* from 30 miles E. of Ravensthorpe, (2) Nungarin, (3) male from Marvel Loch near Southern Cross." Tate (1947, p. 123) records a U.S.N.M. specimen No. 218646 (no skull) from Albany, marked *murina fuliginosa*, which "seems to be a topotype . . . pads are wholly granular". Examination of fresh skins in the W.A. Museum may indicate some distinctive coloration, that of the holotype having been "bleached" by almost a century of spirit preservation.

Sminthopsis froggatti Ramsay.

Antechinus (*Podabrus*) *froggatti* Ramsay, 1887, Proc. Linn. Soc. N.S. Wales, (2) ii, p. 552.

Sminthopsis crassicaudata Thomas, *nec* Gould, 1888, Cat. Mars. & Monotr. Brit. Mus., p. 306, Pl. xxiii, fig. 8 (pes).

Sminthopsis froggatti Troughton, 1932, *Rec. Austr. Mus.*, xviii, 6, p. 352.

Holotype. Adult ♀ in the Macleay Museum, University of Sydney; caught under debris near a beach, in the "pindan" scrub bordering King Sound, near Derby, north Western Australia.

Diagnosis. According to the extended description (1932), total length comparable with *crassicaudata*, but the tail decidedly longer, with the incrassation in the proximal half and tapering to the tip. The ear is much smaller, and the sole-pads differ from the typical *crassicaudata* in having smooth apical summits instead of fine granulations, or

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Legend continued from p. 312.

Fig. 2, A-B. *Sminthopsis hirtipes* Thomas. Holotype. Showing the remarkable pattern, and "gerbille-like" appearance of the manus (2A) and the pes (2B). British Mus. (Nat. Hist.) No. 1879-12.17.1. Joyce Townend del.

Fig. 3, A-B. *Sminthopsis murina tatei,* subsp. nov. Holotype. Fig. 3A, ear, and 3B the pes, showing the typical unworn appearance of the apical row of granules. Aust. Mus. No. M.7157. B. Bertram del.

Fig. 4. *Sminthopsis murina leucopus* (Gray). The pes, showing apparent striations caused by wearing down of the apical row of granules; the striations should be wider apart, representing the divisions between the granules. Tasm. Mus. Pearson Coll. No. 568. B. Bertram del.

Fig. 5, A - B-C. *Sminthopsis murina ooldea,* subsp. nov. Holotype. 5A the head, 5B the manus, and 5C the pes. Aust. Mus. No. M.7502. B. Bertram del.

Fig. 6, A-B. *Sminthopsis lumholtzi* Iredale & Troughton. Showing the ear and tragus (6A), the pes (6B) with the oblong-ovate apical areas; the striae should be finer; compare with figures of pes of *"leucopus"* in the British Museum Catalogue. Aust. Mus. No. M.8420. B. Bertram del.

Fig. 7. *Sminthopsis longicaudatus* Spencer. The pes. W.A. Museum No. M.2394. B. Bertram del.

All drawings approximately twice natural size.

the longitudinal row of enlarged granules typical of *centralis*. Abdominal fur whitish from base to tip, not bicoloured. Dentition much as in *crassicaudata*, but premolars not so evenly increasing in size, pm^1 three-fourths the bulk of pm^3, both definitely smaller than pm^4.

Dimensions of holotype. Adult ♀ in spirit: head and body 73·5; tail 71; pes 14; ear from outer base 14, greatest width 9·5 mm. Skull: Basal length 21·3; zygomatic breadth *c.* 12·5; nasals 8·3 × 2·5; interorbital width 4; palate, length 11·6, ant. for. 2·8; breadth at m^3 7·6; upper tooth-row 11·2; molars$^{1-3}$ 4·5 mm.

Remarks. Named in honour of W. W. Froggatt who obtained the holotype when collecting for the Hon. Wm. Macleay. Froggatt subsequently became a distinguished Government Entomologist in the New South Wales Department of Agriculture. The placing of this species under the synonymy of *crassicaudata* by Thomas, within a year of its description, was not justified because Ramsay's dimensions conflicted with Gould's type, the only correctly localized specimen then available to Thomas. The inclusion of *froggatti* as a race of the eastern *macrura* by Tate (1947, p. 122) shows an even greater disregard for vast separations of faunal habitat. Tate did not examine the holotype, but regarded the smaller ears, basal incrassation of the tail, and granular pads as indicating that the species were "either synonymous or conspecific". Actually, comparison of specimens of *macrura* with the holotype admits no question of the distinction of *froggatti*, quite apart from *centralis*, the intervening sub-desert race of *crassicaudata*.

SMINTHOPSIS HIRTIPES Thomas. (Fig. 2A–B.)

Sminthopsis hirtipes Thomas, 1898, *Novitates Zool.*, vol. 5, p. 3.

Holotype. Adult ♂ in British Museum, No. 97.12.17.1, from Station Point, Charlotte Waters, Central Australia.

Diagnosis. Medium-sized, with remarkably specialized palms and soles, long ears, and tail longer than the head and body, and without definite incrassation. From spirits, colour of back light brown, about sayal (Ridgway), contrasting with the whitish belly; no distinctive facial marks. Palm (fig. 2A) covered by a raised cushion with a central groove but no distinctive pads, and covered with fine white hairs. Sole with conical metatarsal pad unusually elevated, 3 mm. from toe-base to tip, the distal portion with two grooves, and proximal part with a concavity, the whole covered with minute granulations and fine white hairs; silvery-buff hairs of the pes unusually long, notably along the outer edge of the sole where they form a definite silvery fringe.

Skull larger and stouter than in *crassicaudata*, with decidedly larger bullae (Thomas). The pm^4 is exceptionally large (Tate, 1947, p. 124) and pm^1 definitely smaller than pm^3.

Dimensions of holotype. In spirits: head and body 76; tail 81; pes 19; ear 22·5 mm. Skull: Basal length 24; zygomatic breadth 15·3; interorbital 5·1; palate length 13·2; length m^{1-3} 4·7 mm.

Remarks. A young ♀ in the Australian Museum (M.6477) agrees in all external characters with the original description, the feet presenting the remarkably Gerbille-like parallelism described by Thomas. The specimen from "Central Australia", presented by Professor A. A. Abbie of Adelaide University, had the calvarium removed; the premolars appear immature; tail length 79; pes 17·5 (s.u.) mm. Specimens in the W.A. Museum from near the Warburton Range, on the Canning Stock Route through the Sandridge Desert, central Western Australia, were recorded by Glauert (1933, p. 22); recorded also by Finlayson (1961, p. 155) from the area of Lake Mackay, on the south-western border of the Northern Territory.

SMINTHOPSIS MURINA Waterhouse. (Figs 3–5.)

Phascogale murina Waterhouse, 1838, *Proc. Zool. Soc. London*, p. 76.

Holotype. Young ♂ from "Hunter's River", mid-coastal New South Wales, No. 55.12.24.95 in the British Museum.

Remarks. As stated in the Introductory comment, Tate in his review of the genus (1947) indicated the subspecific relationship of *leucopus* of Tasmania, embracing no

doubt *ferruginifrons*, apparently of the Sydney district, about 100 miles south of the holotype locality. However, without a prolonged examination of the extensive series of *murina* (*sens. lato*) in the Australian Museum it is impossible to estimate the specific or racial relationships of the above forms, or that of *albipes*, and *fuliginosa* of south Western Australia. The *murina* "complex" indeed warrants preparation of another paper which it is hoped to undertake after examination of typical material in the British Museum during 1964.

The fact remains that because of the acknowledged lack of differential cranial characters it is impossible to provide objective diagnoses of the typical and allied forms of *murina* at present. However, as previously defined, the sole-pads provide a mutually diagnostic feature in having a longitudinal row of enlarged granules on each summit (fig. 3B), without trace of smooth apical areas, but often having the appearance of apical serrations due to wearing down of the enlarged granules, as figured for a specimen of *leucopus* from "Tasmania" (fig. 4). These "serrations", as noted in the Introduction, are not analogous with the minute apical striae figured by Thomas for *leucopus* in the *Catalogue*. It is a notable fact that Bensley (1903) evidently realized this erroneous association by Thomas, because his figure (Pl. 7, fig. 3) of the sole-pads of *leucopus* is typical of *murina* (*s.l.*).

Gerard Krefft (1866) believed *albipes* and *murina* to be alike, thus anticipating the conspecific treatment by Thomas (1888); while Tate (1947) considered that the general similarity of the skulls "indicates that they are geographical representatives of the one species". Despite the intermediate occurrence of *albipes* of coastal South Australia, it is difficult to reconcile the darker coloured and heavier footed *fuliginosa*, of the more fertile region between Perth and Albany (W.A.), with the subspecific status allotted it by Tate.

In his notes on "*murina fuliginosa*", Tate records the locality of the young adult ♂ in the British Museum as "River Avon, King George's Sound", but collector Gilbert's actual locality was Toodyay, on the Avon River, 15 miles from Northam, and about 50 miles north-east of Perth. This error in location was evidently due to Gould (1852) giving the local name "Twoor-dong—aborigines of King George Sound" at the heading of his description of the "Sooty Antechinus" (vol. 1, Pl. 41). While there may be no material difference in habitat, the specimens examined by Tate in the M.C.Z. from Albany, and from Kojonup, "a few miles to the north", cannot be regarded as virtually topotypical, as stated by Tate.

Regarding the distinctive habits of *fuliginosa*, Gould quoted most interesting field notes for which he was "Indebted . . . to researches of the late Mr. Gilbert" in part: "This is so much like the *Antechinus albipes*, that I considered it to be that animal, until, by hunting for it myself, I found that it not only differs in habits—but is of a somewhat larger size and very much darker colour. Its favourite resorts are newly burnt spots, especially those adjacent to swamps and moist meadows." There is also a detailed description of the nesting burrow, the top of which so resembled the nests of small black ants that Gilbert overlooked hundreds until aboriginals showed them to be nests of the marsupial. The stomachs of the night-feeding marsupials contained a variety of insects.

In his notes on the distribution of Western Australian marsupials, Glauert (1932-33) omitted *fuliginosa*, apparently assuming it to be synonymous with *albipes* for which he gives the range as "more or less coastal, but inland to . . . Bulong, near Kalgoorlie". It was also noted that "All the specimens seen have the carpal pad on the manus transversely striated, not granular". An adult ♂ *fuliginosa* from Tambellup, about 70 miles north of Albany (A.M. No. M.4742), has the total length 190; head and body 97; tail 93; pes 19·3; ear, outer 23, inner 18 mm. A younger male (A.M. No. M.4581), with a 91 mm. tail, has the ear-length 22, and the 19·3 pes a maximum width of 3·7 mm., the measurements generally emphasizing the larger proportions of the south-west coastal form. Subsequent study of the extensive Australian Museum series should establish the full specific status of *Sm. fuliginosa*.

Two new races of *murina* are described as follows:

SMINTHOPSIS MURINA OOLDEA, subsp. nov. (Fig. 5A–C.)

Holotype. Young ♂ M.7502 in the Australian Museum, collected by H. E. Green when mission-teacher at Ooldea on the Trans-Continental Railway, South Australia.

Diagnosis. Sole-pads agreeing with typical *murina*, but the longitudinal apical row of enlarged granules smaller and more bead-like; showing a similar tendency to coalescence with wear. Tail proportionately much longer, slimmer, and less coarsely haired than in *fuliginosa*. Ear comparatively very broad, and the tragus short and broad with the hind margin incurved only near the base. Sub-adult skull affected by maceration; relatively broad, breadth across m^3 7·3 mm., only 1 mm. less than in much larger skulls of *fuliginosa*; nasals proportionately long and narrow, widest within 1 mm. of tips (1·6), tapering posteriorly to 1·1 mm. Canine short and more premolariform; 1st and 3rd premolars subequal, decidedly smaller than pm^4.

Dimensions of the holotype. In spirits: head and body 73; tail 102; pes 18; ear, outer length 18·8, maximum breadth 13 mm. Skull: greatest length *c.* 20; basal length *c.* 18·5; interorbital 4·8; nasals length 7·8; max. breadth 1·6; palate length 10·8, ant. for. 3·1; breadth at m^3 7·3; upper tooth-row 11·7; molars$^{1-3}$ 4·3 mm.

Remarks. Despite the sub-adult condition of the holotype, the granule pattern of the sole-pads allies it with *murina* and distinguishes it from *crassicaudata centralis*, while the relatively very broad ear and length of the "whip-like" tail distinguish it from *centralis* and as a race of *murina*. The situation of Ooldea at the edge of the vast Nullarbor Plain, edged by sand-wave country, and by some richer vegetation, may account for the occurrence of this intermediate form, the description of which may result in the collection of mature examples.

SMINTHOPSIS MURINA TATEI, subsp. nov. (Fig. 3A, B.)

Holotype. Adult ♂ M.7157 in the Australian Museum, from Tolga on the Atherton Tableland, at approximately 2,460 ft, north-eastern Queensland.

Diagnosis. Dimensions in general agreement with *fuliginosa*, at the extreme south-western extension of the distribution, but pes (fig. 3B) larger and tail longer (subequal to head and body) than in any intermediate mainland form, other than the race from Ooldea. Colour from skins of Tableland specimens (fide Tate, 1947) "brownish gray dorsally, much browner than our *S. m. leucopus* . . . underparts have creamy hair tips and gray bases . . . tail gray above, buffy underneath . . . hands and feet are white, much paler than those of our *leucopus*. There appear to be six nipples".

Skull strongly built, broader and more inflated cranially than in other subspecies; width at the stout zygoma 15·6, and breadth at outer m^3 8·9 mm.; nasalia largest in the species, 10·6 × 2·0; there is a weak sagittal crest. Anterior premolars subequal, half the size of the relatively small pm^4.

Dimensions of holotype. Adult ♂ in spirits: head and body 95; tail 94; pes 20; ear, outer length 21·3, inner 17·3, width 15 mm. Skull: greatest length 27·9; basal length 25·4; zygomatic breadth 15·6; interorbital 5·4; nasals 10·6 × 2·9; palate length 14·5, ant. for. 3·5; breadth at m^3 8·9; upper tooth-row 13·8; molars$^{1-3}$ 5 mm.

Remarks. This distinctive Tableland race is named in honour of a much admired friend and associate in mammalogy, the late Dr. G. H. H. Tate, in memory of happy meetings during his visits with the Archbold Expeditions, and at the American Museum of Natural History where he was a distinguished and hospitable Curator in the Department of Mammals. This small tribute is the more appropriate since Dr. Tate (1947) regarded a male in the A.M.N.H., and female in the M.C.Z., from Atherton Tableland as possibly "members of a northern race". However, his decision to regard the specimens provisionally as representing the typical race (of *leucopus*) "in default of topotypes" was unwarranted because the type locality of *murina* is the Hunter River, central coast of N.S.W., and that of *leucopus* is Tasmania. The reference to the Atherton Tableland, at the base of Cape York, as in "central Queensland" is also misleading as to the subspecific proximity.

SMINTHOPSIS MURINA CONSTRICTA Spencer.

Sminthopsis murina var. *constricta* Spencer, 1896, Report on . . . the Horn Scientific Expedition to Central Australia, Zoology, vol. 2, p. 33.

Holotype. From Oodnadatta, north-central South Australia (not seen by Tate, or the author).

Remarks. In the absence of the unique holotype, and because of the inadequate description, there is nothing diagnostic to be said about this "somewhat cryptic form" as Finlayson aptly stated (1961). However, the details of Spencer's description do not warrant the placing of *constricta* as a race of the eastern *macrura* by Tate (1947), or as possibly equalling *centralis*, which had already been clearly established as a northern race of *crassicaudata*. While the relationship with *murina* is extremely doubtful, the lack of striation of the sole-pads has little significance since Spencer did not distinguish between the types of granulation, while the distinct incrassation of the tail would exclude *murina*, though this character proves variable in *crassicaudata centralis* and *larapinta*. The relatively great breadth of the pes in the possibly immature holotype, given as "Hind-foot 15·5 and Greatest width 4 mm." by Spencer, may have appeared to him as the outstanding character, since he did not repeat the width measurement for his *psammophilus*, with the longest foot recorded for the genus.

SMINTHOPSIS PSAMMOPHILA Spencer.

Sminthopsis psammophilus Spencer, 1895, *Proc. Roy. Soc. Victoria*, new ser., vol. 7, p. 223; *Id.*, 1896, Report on . . . the Horn Sci Exped. to Central Australia, Zoology, vol. 2, pp. 35–6, Pl. 1, fig. 2, 2*a*-2*b*.

Holotype. Adult ♂ from near Lake Amadeus in the south-western angle of the Northern Territory. Not seen by Tate or the author.

Diagnosis. Apart from exceptional size, there can be no diagnostic support for the inclusion of this species as a race of *macrura*, by Tate. Failing examination of the holotype, the skull and dentition of which have never been described, it appears that the overall granulation of both manus and pes provides a distinctive character; especially regarding the pes the large size of which (25mm.), coupled with the overall even granulation and lack of either smooth or striated apical summits to the pads, eliminates both *larapinta* and the large-footed and stout-skulled *lumholtzi*.

Other distinctive characters (fide Spencer) include the very large ear (24·5 mm.) extending to half-way between the eye and muzzle when pressed forward. The very long tail (116 mm.) exceeds the head-and-body length (105 mm.), giving a total length of 221 mm., the largest overall proportions recorded for the genus; distinctively, the tail is described and figured as "long and thin" and covered with short whitish hairs, with a well-marked line of black hairs above and below, the hairs increasing slightly in length towards the tip "so as to form a slight crest". Coloration as figured for Spencer; the conspicuous dark flecking of the whitish underpart, not referred to in the description, evidently represents the artist's idea of indicating the dark basal half of the fur.

Remarks. When including this unique species as a race of the south-eastern *macrura*, apparently on the unstriated granulation of the sole-pads, Tate (1947) observed that it "is clearly a very much larger species than either *crassicaudata* or *murina*", a fact equally applicable to *macrura*. However, examination of the holotype, and especially the undescribed skull and dentition, is essential to establishing the affinities of this remarkable species. The habitat was recorded as "living amongst sand-hills covered with tussocks of porcupine grass . . . running about in daytime". There can be no doubt of its specific distinction (Spencer).

SMINTHOSIS LARAPINTA Spencer.

Sminthopsis larapinta Spencer, 1896, *Proc. Roy. Soc. Victoria*, new ser., vol. 8, p. 8; *Id.*, 1896, Report on . . . the Horn. Sci. Exped. to Central Australia, Zoology, vol. 2, pp. 33–35, Pl. 2, figs 2, 2*a*-2*b*.

Holotype. From Charlotte Waters, in the Northern Territory, just north of the centre of the South Australian border.

Remarks. A full diagnosis is dependent on an examination of the typical specimens of *stalkeri* Thomas (1906) in the British Museum, from Alroy Downs in the Northern Territory, about 100 miles from Camooweal on the north-west border of Queensland. The variable coloration is generally as in Spencer's figure, though tending to a lighter cinnamon-buff (Ridgway), notably in an excellent skin in the Queensland Museum from Richmond, north-central Queensland, where *larapinta* overlaps the range of the more robust *lumholtzi*, thereby providing the north-easternmost extension of the known range of *larapinta*.

The small and smoothly rounded apical summits to the sole-pads, as figured by Spencer, and defined comparatively in the Introduction, are diagnostic of the species. As figured, the tail apparently represents the maximum degree of incrassation for *larapinta*, such as noted in an Australian Museum young male (M.3928) from Barcarolle Station, on the Thompson River, 135 miles south of Longreach, Queensland.

The skull is smaller and more delicate in build than that of the stout bony texture of the skull of *lumholtzi*. The 1st and 3rd premolars are finer but relatively subequal and decidedly smaller than pm^1 as in *lumholtzi*, but the canine is relatively much smaller and rather "premolariform", only slightly exceeding the height of pm^4.

Specimens examined. A skin, skulls, and four spirit specimens of the original Spencer series from Charlotte Waters, on loan from the National Museum, and a mounted specimen (M.1142) in the Australian Museum. Other A.M. specimens include one from the Diamantina River, western Queensland; two (M.3928–9) from 135 miles south of Longreach, and two (M.6955–6) from Cunnamulla (Q'ld), about 70 miles from the N.S.W. border, providing the south-easternmost known record for *larapinta*. Besides the valuable series of dried and spirit specimens from Richmond in the Queensland Museum, so kindly lent by the late Director, George Mack, there is a skin and skull from Richmond (M.2173) in the Australian Museum.

The more central range of *larapinta* has been mapped by Finlayson (1961) in his excellent paper, dividing the central region into faunal subdivisions. However, a specimen in the Australian Museum (M.3786) from Helen Springs, about 100 miles north-west of Alroy Downs, occurs well to the north of Finlayson's subdivisions 4 and 5. While emphasizing his statement that the range of *larapinta* probably covers most of "central Australia", the specific status of *stalkeri*, from the locality intermediate between Richmond (Q'ld) and Helen Springs (N.T.) becomes involved.

Sminthopsis stalkeri Thomas.

Sminthopsis stalkeri Thomas, 1906, *Proc. Zool. Soc. London*, p. 543.

Holotype. Sub-adult ♂ B.M. No. 6.3.9.91 from south-west of Alroy, in the Northern Territory, about 100 miles from Camooweal on the north-west border of Queensland.

Remarks. Pending examination of the two apparently sub-adult types in the British Museum, it is impossible to provide a diagnostic comparison, or to confirm the relegation of *stalkeri* to a subspecies of *larapinta*. In adopting this view Tate (1947) noted that Thomas compared *stalkeri* throughout with "*larapinta*", as he had earlier placed Collett's *nitela* in the synonymy of Spencer's *larapinta*. However, because of the occurrence of both *larapinta* and *lumholtzi* to the east, and *larapinta* to the north-west of Alroy, a distribution not then known to Thomas, the status of *stalkeri* remains in doubt. There remains the possibility that the species may actually prove to be identical with *Sm. crassicaudata centralis*, because the general proportions and length of the tail (65–70 mm.) with a basal incrassation is in agreement.

Sminthopsis nitela Collett.

Sminthopsis nitela Collett, 1897, *Proc. Zool. Soc. London*, p. 334.

Holotype. Young adult ♀ B.M. No. 97.4.12.6, in spirits, from the Daly River, probably within 50 miles of Darwin, Northern Territory.

Remarks. It is not clear why Tate placed *nitela* as a subspecies of *larapinta*, because his brief diagnosis shows its affinity to be obviously with his "*rufigenis* Division", inclusive of *lumholtzi*. According to his examination of the holotype, Tate (1947) wrote:

"The median facial stripe, "front and cheeks rufous orange", long canines, very large p^{1-4} are all reminiscent of *S. rufigenis*, but the "smooth (not striated)" pads are not in agreement." Stating that his notes on the type did not cover the sole-pads, Tate evidently exaggerated the importance of the description of the pads in allying *nitela* with *larapinta* rather than *lumholtzi*, the north Australian ally of *rufigenis* of Aru Island, which includes Tate and Archbold's *Sm. rona* of Papua (1936). A specimen in the Australian Museum (M.4403) from 90 miles north-west of Anthony's Lagoon, *en route* to Newcastle Waters (N.T.), is regarded as a sub-adult male of *lumholtzi*. It was collected by my friend T. G. Campbell, ex Museum colleague, and now with the Division of Entomology, C.S.I.R.O. He described the Barkly Tableland habitat as "a treeless black soil plain, with cracks and burrows in the soil in which the mice lived". This note is significant because the types of *nitela* were "brought in by the natives who dug them out in the gardens". Combined with the extension of the range of *lumholtzi* west to Richmond (Q'ld) the above notes confirm the alliance with *nitela*, pending examination of typical specimens in the Oslo and British Museums.

SMINTHOPSIS LUMHOLTZI Iredale and Troughton. (Fig. 6A–B.)

Phascologale virginiae Collett, 1887 (1886), *Proc. Zool. Soc. London*, p. 548, Pl. lx (animal, skull, teeth); *Id.*, 1887, *Zool. Jahrb.*, Jena, vol. 2, p. 866. Not *Phascogale virginiae* De Tarragon, *Revue Zool.*, 1847, p. 177. (No locality, type unknown.)

Sminthopsis lumholtzi Iredale and Troughton, 1934, *Aust. Mus. Memoir* vi, p. 11 (*nom. nov.*).

Diagnosis. As described and figured by Collett and by Oldfield Thomas, who evidently figured the pes of a Cape York spirit specimen in the B.M. *Catalogue* (Pl. xxiii, fig. 6), which was mistakenly applied to the southern *leucopus = murina*, as detailed in my Introduction. This robust species is distinguished by the stout pes which has the summits of the pads with relatively large oblong-ovate smooth areas which are more or less microscopically and transversely striated. As figured by Collett, and confirmed by several specimens listed below, the broad and strongly-built skull is characterized by the parallel breadth of the nasalia, usual presence of distinct postorbital processes, and the overall proportions. Canine very long and rounded, almost double the height of pm^4; premolars rather disproportionate, as in Collett's figure, pm^1 smaller than pm^3 which is about half the size of pm^4.

Measurements of holotype. Combined from Collett and Thomas (in brackets). Total length 245 (250); head and body 125 (125); tail 120 (125); pes c.u. 23 (s.u. 22); ear length 20·5, inner 14·5 (crown 13) mm. Skull: Greatest length 31·5; basal length 29·5 (29·5); zygomatic breadth 19 (19); interorbital 5·5 (6·1); nasalia—(11), breadth (3·1); palate length (16), ant. for. (3·1); breadth at outer m^3 (10·5); upper tooth-row 15 (–); p^4 horizontal length (1·5); molars 1–3 (5·3) mm.

Specimens examined. Two from Hampden, near Mackay, mid-eastern Q'ld (J.3109–10), and two from Julia Creek (J.5173 and J.5459), midway between Richmond and Cloncurry, north-central Qld, in the Queensland Museum collection; a young ♂ from Rocky River near Coen, Cape York Peninsula (M.8420), collected by Basil J. Marlow, and an adult ♂ skin and skull from Richmond, north Queensland (M.2172), presented by the late F. L. Berney, both in the Australian Museum.

Remarks. The name *lumholtzi* was established in tribute to the distinguished author-naturalist Carl Lumholtz, collector of the holotype, because of the lack of a diagnostic description of "*virginiae*", the lack of indication of locality, and of any indication of the existence of a type specimen or its place of lodgement. Considering the lack of objective characters in many species, and the great extensions of range now revealed, lack of location, in the absence of a type, becomes decisive.

Tate (1952) makes some important notes regarding the habitat and range of the species: "The type locality of *virginiae* Collett (not Tarragon) = *lumholtzi* Iredale & Troughton was given as Herbert Vale, in the upper Middle part of the Herbert River, doubtless where its headwater streams drain the grassy portions of the southern part of the Atherton Tableland before cutting down into the rain forest." He further stated

that the distribution pattern corresponded rather closely with a number of other "open-forest" species of marsupials and the naked-tailed rat *Melomys lutillus*. He found that *lumholtzi* avoided the dense rain-forest, favouring open "rocky forest and brushy places in full sunlight", and he suspected that it sometimes ate parts of the *Melomys* caught in traps. A female had the nipple formula $4-4=8$, whereas the formula of Papuan specimens of *rufigenis* appeared to be $3-3=6$, observed on dry skins.

Sminthopsis longicaudata Spencer. (Fig. 7.)

Sminthopsis longicaudata Spencer, 1909, *Proc. Roy. Soc. Victoria*, new ser., vol. 21, p. 449.

Holotype. In the National Museum, Melbourne, described as from "West Australia", but L. Glauert, when Curator of the Perth Museum, concluded that the collector, G. A. Keartland, had obtained it in the region Pillendinnie (Marble Bar), Western Australia. The second known specimen, in the Western Australian Museum (No. M.2394) from the same area, was kindly lent for examination by the Director, Dr. W. D. L. Ride.

Remarks. In view of the impending paper to be published on the Western Australian species of *Sminthopsis*, it does not appear warranted to attempt a review of the characters or genetic relationships of this remarkable long-tailed species. As Tate stated (1947), the species "apparently represents a special, long-tailed development of the division of *Sminthopsis* having striated pads. As its describer pointed out, the tail is proportionately even longer than that of *Antechinomys*. There is no corresponding lengthening of the foot (18 mm.)."

Regarding the possible phylogenetic relationship with other genera, such as *Antechinomys* and *Antechinus*, it seems difficult to reconcile the lack of a hallux and the large cushion-pads of *Antechinomys* with the strong hallux and the divided and coarsely serrated pads of *longicaudata*. The remarkably long tail would be quite incompatible with the movements of *Antechinomys*, while its appearance otherwise agrees with *Sminthopsis*. The slenderness of the pes, apical serrations of the interdigital pads, and lack of any additional pads disagree strikingly with the pes of *Antechinus*. The species may represent some annectant generic form, based on cranial characters, but it seems difficult to relate it to the genera referred to within the scope of Bensley's phylogenetic review.

Acknowledgements.

Sincere thanks are expressed to the Trustees and Director (Dr. J. W. Evans) of the Australian Museum for making ample facilities available for the preparation of this paper, under my appointment as an Honorary Zoologist; and to my successor as Mammalogist, Basil Marlow, B.Sc., for graciously making the remarkably rich collection of Sminthopsids available for research. A revision was actually contemplated after examining typical specimens in the British Museum in 1930, when the fine drawings of *Sm. hirtipes* were kindly made for me by Miss Joyce Townend. Also when Dr. T. C. S. Morrison-Scott, now Director of the Natural History Museum, kindly obtained photos and drawings of the Gouldian "co-type" of *Sm. macrura* in the Liverpool Museum, afterwards destroyed by enemy action. More recently, J. Edwards Hill of the Mammal Section supplied sketches and notes of type specimens. Very keen appreciation is expressed to the memory of the late Director of the Queensland Museum (George Mack, B.Sc.) for his encouraging interest in making the entire Sminthopsid collection available for review. Thanks also go to my old friend C. W. Brazenor who, prior to retiring as Director of the National Museum of Victoria, made specimens of Baldwin Spencer's *Sm. larapinta* available for comparison; also to the Director of the Tasmanian Museum, Dr. W. Bryden, for lending the only available topotypical specimen of *Sm. leucopus*. At the Australian Museum, special thanks are due to my old colleague, G. P. Whitley, Curator of Fishes, for overseeing the manuscript for publication and, with the collaboration of Tom Iredale and Basil Marlow, completing the extensive bibliography. Finally, to Dr. D. F. McMichael, Curator of Molluscs, for the essential facilities provided within his Department, and for his effective arrangement of the plate. The excellent drawings, other than of *Sm. hirtipes*, were made by Brian Bertram of the Museum Department of

Art and Design, and a number of skilful preparations were made by Mr. Rolph Lossin and his assistant. To all grateful thanks for valued help in bringing the complex work to finality.

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